

PRODUCTIVITY IMPROVEMENT FOR FURNITURE INDUSTRY BY USING
WITNESS SIMULATION SOFTWARE

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Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering with Manufacturing Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

DECEMBER 2010

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.

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I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ACKNOWLEDGMENTS

First of all, I would like to express my sincere gratitude to my supervisor, Mr. Hadi Bin Abdul Salaam for his germinal ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. He has always impressed me with his passion towards his job and his tolerance of my naïve mistakes. I would also like to thank him for the time spent proofreading and correcting my many mistakes.

Furthermore, I would like to thank the director or owner of Lein Hua Furniture Industry Sdn. Bhd., Mr. Wan Hassan Bin Wan Omar who willing to share information about his company and allowing me to undergo this project at the company. With his kindness on letting me visit the company at anytime during operation hours directly sped up the completion of my data collection. In addition, the appreciation is dedicated to the supervisor and workers of the company as the co-operation from them is of utmost importance, too.

I acknowledge my sincere indebtedness and gratitude to my parents, family members, and friends for their love, dream and sacrifice throughout my life. Special thanks to my parents who always supporting me along my study life and whenever I face difficulties. Anyway, the love from GOD will always be remembered as I was given the chance to complete my project smoothly without any hardship.

ABSTRACT

A furniture industry typically involves a number of stages, including receiving raw materials, cutting, sanding, laminating, shaping, drilling, brushing, assembly, and finishing. The longer of process cycle time, the frequent of machine downtime, and the poor layout of the factory have added to the complexity and challenges of furniture industry. With respect to the project title, Productivity Improvement for Furniture Industry by using WITNESS Simulation Software, Lein Hua Furniture Industry Sdn. Bhd. (LHF) has been selected to be improved. The objective for LHF has always been to achieve better productivity, reduce the processing time, minimize the machine downtime, and meet regulatory requirements. This study focuses on applying simulation method to improve the operations in the LHF industry. Therefore, the project objectives can be briefly explained as to design and improve the floor layout of LHF, analyze the designed layout and select the best solution. The project is started by evaluating and identifying the problems existed in the industry, continued by data collection for the data analysis and proceeds to applying simulation modelling step. Meantime, there are three alternatives for improving productivity are suggested and the best of it to be chosen. By running an experiment on the suggested alternatives to improve the output of chairs, these alternatives are modeled in the WITNESS Simulation software and run for the experimental time of 8 hours. These results are analyzed by Kruskal-Wallis and one way ANOVA test for the best solution selection. The experimented results are then being compared with the Cost-Effectiveness Analysis to determine the most efficient layout that are able to produce high output of chairs with lowest cost. From the findings, the most productivity improvement method is the Alternative 3, which is additional of a Laminating machine and reduction of a Brushing machine, as well as combination of Sanding II and Sanding III process after Drilling process. This approach increases the daily output of chairs from 44 to 46 units and the cost of chair per unit from RM45.53 reduced to RM43.63. Therefore, the objectives of this project have been achieved and the selected alternative will be proposed to the LHF for implementation.

ABSTRAK

Lazimnya sebuah industri perabot memerlukan beberapa peringkat, termasuk penerimaan bahan mentah, pemotongan, pelicinan, pelapisan, pembentukan, pelubangan, pemberusan, pemasangan, dan penyelesaian. Kitaran masa proses yang lama, kebarangkalian kerosakan mesin yang tinggi, serta kelemahan susun atur kilang, sememangnya menyumbang kepada kerumitan dan sebagai cabaran terhadap kilang perabot. Dengan tajuk projek yang berbunyi “Peningkatan penghasilan produk di kilang perabot melalui perisian simulasi WITNESS”, *Lein Hua Furniture Industry Sdn. Bhd.* (LHF) telah dipilih untuk ditingkatkan penghasilan produknya. Objektif LHF selama ini adalah untuk mencapai penghasilan produk yang baik, mengurangkan masa pemprosesan, mengurangkan kekerapan kerosakan mesin, serta menepati syarat keperluan. Tesis ini menfokus kepada pengaplikasi kaedah simulasi untuk menambahbaik operasi-operasi di industri LHF. Oleh demikian, objektif projek boleh diringkaskan seperti mana untuk reka dan menambahbaik susun atur kilang LHF, analisis terhadap susun atur yang direka serta memilih antara yang terbaik. Projek ini dimula dengan penelitian dan penentuan masalah yang terdapat di industri, kemudian mengambil data untuk analisis serta diteruskan dengan mengaplikasi kaedah simulasi. Pada masa yang sama, tiga alternatif disaran dan antara yang terbaik akan dipilih. Dengan menjalankan ujian terhadap alternatif yang bertujuan untuk meningkat jumlah kerusi dihasil, kesemua model alternatif akan diuji dengan perisian simulasi WITNESS untuk 8 jam simulasi. Keputusan yang diperoleh akan dianalisis dengan *Kruskal-Wallis* dan ujian *one way ANOVA* untuk pilihan alternatif terbaik. Keputusan eksperimen ini kemudian dibanding dengan *Cost-Effectiveness Analysis* untuk menentukan tapak susun atur yang paling efisien dan mampu menghasilkan jumlah kerusi yang tinggi malah dengan kos terendah. Dari penemuan, kaedah yang paling berkesan dalam peningkatan produktiviti merupakan kaedah ketiga dimana ia adalah penambahan satu mesin pelapisan dengan pengurangan satu mesin pemberusan, serta penggabungan proses pelicinan II dan pelicinan III selepas proses pelubangan. Kaedah ini meningkat penghasilan kerusi harian dari 44 kepada 46 serta kos satu kerusi dari RM45.53 menjadi RM43.63. Justeru, tujuan projek ini telah dicapai dan alternatif yang dipilih akan dicadangkan kepada LHF untuk pelaksanaannya.

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LIST OF SYMBOLS

\bar{X}, μ	Mean
s, σ	Standard deviation
α	Significant level
Σ	Sum or total value
\approx	Approximately equals to

LIST OF ABBREVIATIONS

LHF	Lein Hua Furniture Industry Sdn. Bhd.
MTIB	Malaysian Timber Industry
MIER	Malaysian Institute of Economic Research
ANOVA	Analysis of Variance
FYP	Final Year Project
CEA	Cost-Effectiveness Analysis
WIP	Work In Progress
RM	Ringgit Malaysia

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In today competitive market, the survival of any industry is greatly depends on response time, production costs and flexibility in manufacturing (Chase et al. 2001). For almost all manufacturing industry, an increased productivity and better overall efficiency of the production line are the most important goals. Most industries would like to find the recipe for the ultimate productivity improvement strategy. However, those same industries that are searching for this holy grail are likely to have found themselves unable to take full advantage of the methodologies and techniques so far tried. Part of this is because many of them simply do not understand what productivity really means. (Baines A., 1997).

In order to overcome the lower productivity problem, a thorough understanding and research of the process in the existing company is necessary so that an efficient improvement can be generated to increase the productivity in the researched company. In fact, there is a good number of management techniques such as zero inventory (ZI), just-in-time (JIT), flexible manufacturing system (FMS), optimized production technology (OPT) and total quality management (TQM) that support the implementation of productivity improvement plans. (McTavish R. et al. 1996). However, there is another method which is the most welcoming among these methods – productivity improvement via simulation method.

Simulation is a process of building a model that mimics reality. It provides a greater understanding of the company layout or system being studied. In a

manufacturing industry, simulation is a concept of creating the existing production floor using simulation software. The reason of creating the existing production floor is to analyze and evaluate the existing production floor performance which in turn, leads to cost and time reduction, increment of revenue as well as production productivity.

This chapter provides an overview of the case study titled “Productivity Improvement for Furniture Industry by using WITNESS Simulation Software”. Generally, problem statements will briefly discuss about the problems that furniture industry faced during the production of a product.

In this chapter, an overview of the objectives of this case study and scope of this case study will be reviewed. Basically, the objective of this study is to find an alternative way to increase productivity. This study will be done in one of the furniture industries in Malaysia. In this chapter, the review of the report arrangement will be discussed in general.

1.2 PROBLEM STATEMENTS

In furniture industry, production floor layout involves the arrangement of machines that used to produce a product, the buffer that used in the production floor to store the parts temporarily, and the raw material storage that will be sent to manufacture products. There are several methods available to design, analyze and redesign of production floor layout to improve productivity of a production line.

The furniture industry of Lein Hua Furniture Industry Sdn. Bhd. is selected after some inspection is due to the unsatisfactory of the existing floor layout that causes the low daily production. Therefore, analysis and improvement for the production floor layout will be done in this project in order to enhance the productivity of the industry.

Today, there are plenty of simulation software such as ARENA, Quest, ProModel and WITNESS were developed to allow users to model current existing production floor layout for evaluation. By applying simulation software, the actual

problems can be modeled in the software rather than rearranging the actual machine first before evaluation as it might be risky.

This study would illustrate the process flow of the current existing production floor layout to evaluate the current production performance. Designs of a few more alternatives will be proposed to assist the company to improve the productivity maintaining or even reducing the operating cost.

1.3 OBJECTIVES

The objectives of this study are:

1. To identify problems in existing production floor layout.
2. To design and improve manufacturing production floor layout by using simulation software and by observation during the collection data of cycle time as well as machine downtime.
3. To measure manufacturing performance such as production quantity, lead time, bottle neck and by using cost effectiveness analysis.

1.4 PROJECT SCOPES

This study will analyze an industry specific problem of production floor layout in order to increase the productivity and solve it through several alternative production floor layouts.

- i. This study is conducted at Lein Hua Furniture Industry Sdn. Bhd. (LHF) which located at Semambu, Kuantan, Pahang.
- ii. One production line involved, which is the chair production.
- iii. Production floor layout evaluation will be done with WITNESS Simulation Software and results analysis will be done by using Cost-effectiveness Analysis and Minitab Software.
- iv. This study evaluates daily output of production and average processing time generated from the simulation experimentation.

1.5 REPORT ARRANGEMENT

This study is divided into seven chapters. In the first chapter, the introduction of the study will be discussed. This chapter will be provided with the problem statements and objectives of the study. An overview of scopes of the study will be discussed. Then, the report arrangement of this project also will be reviewed in this chapter.

For chapter two, the literature review of the study will be discussed. This chapter provides with the introduction to furniture industry in Malaysia. Besides, the definition of productivity will be discussed. The interpretation of simulation and simulation methodology will be reviewed in this chapter. Lastly, the previous researches that related to this study will be included in this chapter.

In chapter three, the introduction of the furniture industry background is to be reviewed. The company profile including organization history of establishment, company logo, company objectives, vision and mission are shown in this chapter. In addition, the company organization chart and its production floor layout are attached for reference. Lastly, the process flow of the chair production line is described in detail.

In chapter four, the flow of methodology will be reviewed. The discussion of the methodology used in conducting this study from the beginning until the study is completed is shown in this chapter. The design of the study and the framework of the study will be reviewed at first. Then, the project flow chart for final year project semester 1 and semester 2 also will be included in this chapter.

In chapter five, a conceptual model is included as to reflect the pre-model of the production floor layout. Then, the performance measure and the decision variables are discussed. It proceeds with the discussion of method used to analyze data. Furthermore, the model description, model assumptions, and model construction are included and explained in details. Lastly, this chapter ends with determining the required number of replications before proceed to ANOVA analysis.

Chapter six, on the other hand, consists of the discussion of the existing layout performance and the proposed alternatives layout results. Three alternatives have been suggested in this chapter in order to improve the low productivity of the existing layout. The results generated from the WITNESS Simulation software is tested using Minitab software. The result analysis is then discussed in general. Lastly, the cost-effectiveness analysis for the existing layout and proposed layouts is determined in this chapter.

In chapter seven, it summarizes the results that obtained in previous chapter. The project summary and project findings are discussed in this chapter. The most efficiency layout among the suggested alternatives will be proposed to the LHF. Further improvement and recommendations for this company is also included in this chapter.

1.6 CONCLUSIONS

As a conclusion, the overview of this project is reviewed. It introduces a brief concept of the project by developing the idea of the problems faced by the furniture industry. The problem statements are identified after selecting the suitable researched company. The objectives and scopes of the project are stated to specify the boundary of the study to avoid any deviation from the title of the project. Lastly, the arrangement of report displayed the summary of each chapter discussed in this project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discussed about literature review of simulation study in improving the productivity of a furniture industry, which is Lein Hua Furniture Industry Sdn. Bhd. (LHF). It began with the introduction to furniture industry and the definition of productivity. The simulation including its areas of application, advantages and disadvantages, and its importance are discussed in general. This followed by the general procedure for simulation methodology. Finally, a total of ten previous researches that are related to this study are included as references.

2.2 INTRODUCTION TO FURNITURE INDUSTRY IN MALAYSIA

The furniture industry in Malaysia plays a key role in the country economy. Since the late of 1970s, the government has considered it as a strategic one and encouraged its development with investment in infrastructures and incentives to export. Therefore, a traditional sector based on small craftsmanship enterprises has gradually transformed into a major industry.

In 2007, there were about 2,965 furniture plants in Malaysia, with 2,630 in Peninsular Malaysia, 120 in Sabah and 215 in Sarawak. It is estimated that 70% were small scale plants such as workshops and backyard factories using low level production technology and catering to domestic markets (MTIB, 2007). The remaining 30% were large and medium sized furniture plants which have penetrated the export markets

(MTIB, 2007). In terms of ownership, it is estimated that more than 75% of the furniture companies are either wholly or majority Malaysia owned (MIER, 2008).

Generally, the Malaysian furniture manufacturers can be categorized into four categories:

- i. Small and medium scale industries established and operating in the furniture village.
- ii. Small scale industries established and operating outside the furniture village.
- iii. Medium and large manufacturing companies – local owned.
- iv. Large manufacturing companies – joint venture and foreign owned.

The furniture mills in Peninsular Malaysia are more developed and most of these mills are located on the West Coast (MIER, 2008). The highest number of furniture exporter manufacturing plants are in the state of Johor, followed by Selangor, Perak, and Kedah (MTIB, 2009). In Johor, the highest concentration and most productive manufacturing plants are in Muar, while in Selangor they are in the Klang Valley area. The location of furniture establishments in these states are greatly influenced by proximity to the supply, distance to the export exit points, access to labors, and the availability of good infrastructure, supporting industries, and facilities.

Furniture of both wood and rattan are the stars of the timber sector. Under the concerted efforts of the various development agencies, exports of furniture have increased tremendously nowadays. The United States represents the largest single market for Malaysian furniture, in which in the year of 2007, the United States accounted for 42% of Malaysian furniture exports. The U.S. imports from Malaysia consisted mainly of wooden chairs and miscellaneous wooden furniture, dining tables, and furniture parts.

Japan is the second largest wood furniture importing country after the United States. The European furniture market is the largest in terms of consumption and value in the world. However, the European Union remains a difficult market for Malaysian furniture exporters to penetrate. The United Kingdom and the Netherlands are the two largest markets for Malaysian furniture, too. Other major markets are Singapore and

Taiwan. Currently, most of the furniture is segmented for the medium and lower end market.

Nonetheless, there are factors affecting the export of furniture from a country, which can be divided into domestic and international trade factors. The domestic factors include the supply of raw materials from both domestic log productions and import sources, and the export levy and quota rules. International trade factors, on the other hand, are the currency exchange rates and import price indexes. All in all, the most important factors influencing the success of a furniture mill are the mill's primary characteristics, decision maker's expectation of exporting and global marketing strategy.

2.3 PRODUCTIVITY

Productivity can be defined as the application of the various resources or inputs of an organization, industry or country, in order to achieve certain planned and desired results or outputs. In other words, productivity more broadly means production rate per unit of input, especially per unit of labor, for goods or services (Young and Murray, 2005). It is one of the key factors affecting the overall competitiveness of an organization, in such a way that by improving productivity means improving efficiency.

Productivity improvement can be considered as a process to achieve higher levels of output while consuming same or lesser amounts of input resources. Additionally, if the same output level is reached in a shorter time period, it indicates improved productivity as well. Today's global competition requires increased throughput levels over lesser time horizons.

2.3.1 Productivity Measurement

Productivity can be measured in two ways: single-factor productivity and multifactor productivity. By definition, the use of just one resource input to measure productivity, as shown in Eq. (2.1), is known as single-factor productivity. Multifactor productivity, however, is defined as a broader view of productivity, which includes all

inputs, such as labor, material, capital, energy, and miscellaneous. It is also known as total factor productivity and is calculated by combining the inputs units as shown in Eq. (2.2). (Heizer and Render, 2008).

$$Productivity = \frac{Units\ produced}{Inputs\ used} \quad Eq. 2.1$$

$$Productivity = \frac{Output}{Labor + Material + Energy + Capital + Miscellaneous} \quad Eq. 2.2$$

The two productivity measurements above help in determining the production performance. However, the results can be expected to vary. This is because if labor productivity growth is entirely the results of capital spending, measuring just labor distorts the results. Therefore, multifactor productivity is usually more suitable to use although it is more complicated. The measure of multifactor productivity provides better information about the trade-offs among factors, but substantial measurement problems remain. According to Heizer and Render (2008), the measurement problems include the change of quality when the quantity of inputs and outputs remains constant, external elements may cause an increase or decrease in productivity for which the system under study may not be directly responsible, and also the precise units of measure may be lacking.

2.4 SIMULATION

Simulation is an important problem-solving methodology for the solution of many real-world problems in the manufacturing industry. A traditional definition of simulation is the act or process of simulating, feigning, the imitative representation of the functioning of one system or process by means of the functioning of another, which the examination of a problem often not subject to direct experimentation by means of a simulating device. However, simulation software designers generally define simulation as imitating the operations of various kinds of real-world facilities or processes, the process of designing a mathematical-logical model of a real system and experimenting with this model on a computer.